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Project Summary

Case Studies: Low-VOC/HAP Wood Furniture Coatings

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The report gives results of a study in which wood furniture manufacturing facilities were identified that had converted at least one of their primary coating steps to low-volatile organic compound (VOC)/hazardous air pollutant (HAP) wood furniture coatings [high-solids, waterborne, ultraviolet (UV)-curable, or powder coatings]. Twenty-five case studies were developed, based on visits to the facilities and discussions with plant personnel.

The case studies identify:

- **Products manufactured,**
- **Types of low-VOC/HAP coatings implemented,**
- **Equipment and process changes required,**
- **Problems encountered during the conversions,**
- **Advantages/disadvantages of the low-VOC/HAP coatings,**
- **Customer feedback,**
- **Costs associated with conversions, and**
- **Emissions and waste reductions.**

General information about the wood furniture manufacturing industry's typical emissions and applicable regulations also is provided in the report. Each coating technology is discussed individually and facilities' experiences with the low-VOC/HAP coatings studied are summarized. The main goals of the study were to demonstrate that low-VOC/HAP coatings can be used successfully by some wood furniture manufacturers and to provide a resource to assist other manufacturers in converting to low-VOC/HAP coatings.

This Project Summary was developed by the National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Many wood furniture manufacturing facilities are subject to surface coating regulations that require them to use finishes with low-volatile organic compound (VOC) or hazardous air pollutant (HAP) contents. However, moving away from the conventional, solvent-borne, nitrocellulose-based finishes that have been used for many years concerns some wood furniture manufacturers. Each alternative to traditional solvent-borne coating systems raises different concerns (e.g., quality and appearance of final product, changes to plant operations, and cost). To address these concerns, the U. S. Environmental Protection Agency (EPA) initiated a cooperative agreement with Midwest Research Institute (MRI) to find facilities that were using low-emitting coatings successfully and to provide information on their experiences to the industry. The low-VOC/HAP coatings studied were waterborne, ultraviolet (UV)-cured, high-solids, and powder coatings. Table 1 summarizes the potential advantages and disadvantages associated with each of the four types of low-VOC/HAP wood coating technologies studied.

The primary goals of the study were to demonstrate that low-VOC/HAP coatings can be used successfully by wood furniture manufacturing facilities and to provide a resource to assist other wood

Table 1. Advantages and Disadvantages of Low-VOC/HAP Coatings	
Advantages	Disadvantages
High-Solids Coatings	
High solids, better coverage	Still use organic solvent
Lower VOC/HAP content than traditional coatings	May have to heat lines to reduce viscosity Flammability issues
Low capital cost to change	
Little or no equipment changes necessary	
Easy operator transition	
Waterborne Coatings	
High solids, better coverage	May have longer dry time or require ovens
Low VOC/HAP content	May not produce desired appearance
Lower fire risks, no in-house storage requirements	Need to replace application equipment with stainless steel or plastic
Hard finish	Do not re-wet after they have dried like nitrocellulose coatings do
Low capital cost to change	
Can clean equipment with water	
Less toxic coatings, no smell	
UV-Cured Coatings	
Very high solids, little or no solvent	High capital cost to convert
Low or no VOC/HAP content	Difficult to apply to three-dimensional pieces
Very durable finish	Rework difficult
Cures in seconds, no dry time	Safety considerations with coatings and UV light
Automated line (labor saver)	
Powder Coatings	
100% solids, no solvent	Limited application in wood finishing
No VOC/HAP content	Best for engineered wood substrates
Recycle overspray	High capital cost to convert
Very durable finish, only one coat necessary	
Automated line	
Short cure time	
Easy to clean equipment	

furniture manufacturing facilities in converting to low-VOC/HAP coatings. Facilities were identified that had converted one or more of their primary coating steps to low-VOC/HAP coatings and wanted to participate in this study. Information was gathered using Internet searches, trade publications, trade associations, state agency personnel, technical assistance providers, and coating suppliers. Facility personnel were contacted by phone and, in most cases, a site visit was conducted. They were then given the opportunity to review and comment on the case study writeup for their facility before it was finalized.

Emissions in the Wood Furniture Industry

There are many sources of VOC/HAP emissions in the wood furniture industry. The primary emission sources include:

- Finishing (spray booths, flashoff areas, ovens),
- Cleaning,
- Mixing,
- Touch-up and repair, and
- Gluing.

Finishing

Finishing operations typically account for the largest portion of the facility-wide VOC/HAP emissions. Wood furniture finishing consists of the application of a series of color coats and/or clear coats. The furniture may be sanded, rubbed, or polished between coats, and may pass through drying ovens or flashoff areas. Typical pollutants emitted include alcohols, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), toluene, and xylene. Acetone, although not considered a VOC or HAP, also is emitted by the industry in large quantities. It is assumed that all solvent in the applied finish evaporates during the finishing process, either as the coating is applied or as it dries or cures.

Cleaning

Emissions of VOCs/HAPs are generated from cleaning operations if an organic solvent is used to clean application equipment, spray booths, or other equipment. Organic solvent is necessary to clean equipment that has been used to apply solvent-borne and UV-cured coatings, while hot water can be used to clean equipment that has been used to apply waterborne coatings. Roll coaters are cleaned by soaking the roll in either water or solvent, depending on the type of coating being used. A spray gun usually is cleaned by soaking it in solvent or sending solvent or water through it and

atomizing the liquid into the booth ventilation system. This practice is common unless a dedicated coating supply line and spray gun are used for each color or type of coating. Using dedicated lines produces a significant reduction in cleaning emissions. If a facility is using powder coatings, there are little or no emissions of VOC from cleaning, since the equipment can be wiped down with a cloth or blown out with air.

Mixing and Touch-up/Repair

Some VOC emissions may occur during mixing operations if volatile materials, such as thinning solvent, are used or if material leaks or is spilled. However, most facilities purchase their finishing materials ready to use (no thinning is required). Touch-up and repair operations are a source of VOC emissions if solvent is used to strip a piece of furniture or perform spot rework.

Gluing

Gluing operations can potentially be as large a source of emissions as finishing operations, depending on the type of glue used. In the past, glues containing methylene chloride were widely used and could account for a significant portion of a facility's HAP emissions. In recent years, wood furniture plants have transitioned to waterborne, hot melt, or low-VOC/HAP adhesives as alternatives.

Wood Furniture Industry Regulatory Requirements

In 1995, the EPA promulgated National Emission Standards for Hazardous Air Pollutants (NESHAPs) for the wood furniture manufacturing industry. With some exceptions, the NESHAPs apply to wood furniture manufacturing facilities that emit 10 tons or more per year of one HAP or 25 tons or more per year of any combination of HAPs. The NESHAPs require facilities to implement work practice standards and provide pollution prevention alternatives as compliance options. Facilities can implement low-HAP coating and gluing technologies rather than installing an air pollution control device. For wood furniture manufacturing facilities, implementing low-VOC/HAP coatings often is the most cost-effective option. However, many facilities subject to NESHAPs simply reformulated their solvent-borne coatings to include solvents that are considered VOCs but not HAPs.

In 1996, the EPA issued a Control Techniques Guideline (CTG) Document, which outlined methods of reducing VOC emissions from wood furniture finishing operations. The CTG recommended the use of waterborne topcoats or high-solids sealers and topcoats as reasonably available control technology (RACT) for finishing operations. States must implement rules that require wood furniture manufacturing facilities in ozone nonattainment areas to control VOC emissions to levels at least as stringent as those recommended in the CTG.

Case Studies

Twenty-five case studies were prepared during this study for a variety of facilities, products, and coating technologies. Facilities in 13 states were studied. Five facilities were located in ozone nonattainment areas. Visits were made to 23 of the 25 facilities. Facilities ranged in size from 2 to 900 employees, with products ranging from coated panels used as casegood components to high-end furniture and cabinets.

Table 2 shows the distribution of the facilities by product and coating type. Many facilities use more than one type of low-VOC/HAP coating technology, and those facilities appear in more than one category (e.g., one plant was using waterborne, UV-cured, and powder coatings). Nine of the facilities studied had converted all of their coating steps to low-VOC/HAP coatings.

Reasons for Converting Coatings

The facilities cited several reasons for switching to low-VOC/HAP coatings and implementing other pollution prevention measures:

- A desire to use materials that are less hazardous,
- A commitment to the environment,
- To avoid being subject to the NESHAPs for wood furniture manufacturing,
- In anticipation of having to comply with the wood furniture NESHAPs,
- As part of an overall pollution prevention program,
- A desire for a higher-quality finish,
- To lower emissions, and
- To increase production without increasing emissions or exceeding permit limits.

Emissions Reductions Achieved

The facility-wide VOC emissions reductions achieved by implementing pollution prevention measures (such as low-VOC coatings) ranged from about 12 to 98%. The costs incurred or saved in converting to the new coating systems included capital costs, material costs, labor costs, and energy costs. Facilities that converted to high-solids or waterborne coatings typically experienced the lowest conversion costs. Costs and cost savings for materials, labor, and energy varied widely among facilities.

Costs

Cost savings were incurred when facilities were able to reduce labor costs, material usage, fire insurance, and permit/waste disposal fees. Often, a cost saving was experienced even if the cost of the coating increased, due to lower labor costs, a more efficient application technique, or higher coating solids content.

Other Benefits

The facilities studied achieved benefits in addition to reductions in cost and emissions of VOCs/HAPs when they implemented pollution prevention measures:

- Reduction or elimination of hazardous waste,
- Reduction in wasted materials (e.g., coating, solvent, or wood),
- Reduction of fire risk,
- Improved working conditions,
- Enhanced company image,
- Improved coating performance, and
- Increased production capacity.

Table 2. Breakdown of Facilities Studied by Product and Coating Type

Low VOC/HAP Coating Technology	Product Type		
	Residential Furniture	Office/Institutional Furniture	Cabinets or Components
High-solids	3	1	2
Waterborne	7	4	4
UV-cured	2	4	4
Powder	0	1	0

Conclusion

The main goals of this study were to demonstrate that low-VOC/HAP coatings can be used successfully by some wood furniture manufacturers and to provide a resource to assist other manufacturers in converting to low-VOC/HAP coatings. By presenting pollution prevention case studies that apply to a variety of wood furniture manufacturers and coating types, these goals have been accomplished. Each facility studied experienced numerous benefits from converting to low-VOC/HAP wood coatings, including emissions, waste, and cost reductions, and quality and safety improvements.

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***Julian W. Jones** is the EPA Project Officer (see below).*
The complete report, entitled "Case Studies: Low-VOC/HAP Wood Furniture Coatings," (Order No. PB2000-106 999; Cost: $36.00, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 605-6000
(800) 553-6847 (U.S. only)
The EPA Project Officer can be contacted at:
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